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RETRO-FIT EMISSION CONTROL DEVICES FOR  
PRE-1968 VEHICLES

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National Air Pollution Control Administration  
Ann Arbor, Michigan

July 1970

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**Division of Motor Vehicle Research and Development**  
**National Air Pollution Control Administration**  
**Department of Health, Education, and Welfare**

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| 16. Abstracts<br>Results, discussions and tabulated test data are presented for an emission program conducted with pre-1968 uncontrolled automobiles equipped with newly developed retrofit devices for reducing exhaust emissions. Three automobiles were selected to be used as test vehicles: a 1962 Chevrolet Biscayne with a 283 cu. in. engine and automatic transmission, a 1963 Chevrolet Impala with a 283 cu. in. engine and standard transmission, and a 1963 Ford Galaxie with a 289 cu. in. engine and automatic transmission. For the series of tests Iodolene 30 was used and fuel consumption was measured for each test by weighing the test fuel tank before and after each run. All tests were cold start. The following tests were performed on both the uncontrolled vehicle tuned to recommended manufacturer specifications and on the same vehicle after installation of the retro-fit device: (1) 1968 Federal procedure for exhaust emissions (FTP); (2) 9 cycles of the 7 mode Federal cycle used with constant volume sampling (CVS); (3) proposed 1972 LA4-S3 test cycle with constant volume sampling (CVS). |  |                            |                                                  |                                            |
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Subject: Used Car Test Program Results

General Motors Inc., Ford Motor Co., and Chrysler Corporation have developed retro-fit devices to be applied to pre-1968 uncontrolled vehicles as a means of reducing emissions from the large population of such automobiles. Because of preliminary claims by manufacturers which created interest in state legislation, an emission test program was initiated.

Three automobiles from the HEW fleet in Ypsilanti were selected to be used as test vehicles. These cars included: a 1962 Chevrolet Biscayne with a 283 cubic inch engine and automatic transmission, a 1963 Chevrolet Impala with a 283 cubic inch engine and standard transmission, and a 1963 Ford Galaxie with a 289 cubic inch engine and automatic transmission. For the series of tests Indolene 30 was used and fuel consumption was measured for each test by weighing the test fuel tank before and after each run. All tests were cold start.

The following tests were performed on both the uncontrolled vehicle tuned to recommended manufacturer specifications and on the same vehicle after installation of the retro-fit device according to the instructions supplied with the devices.

1. 1968 Federal procedure for exhaust emissions (FTP).
2. 9 cycles of the 7-mode Federal cycle used with constant volume sampling (CVS).
3. Proposed 1972 LA4-S3 test cycle with constant volume sampling (CVS).

The 1968 Federal procedure data were obtained with NDIR instruments while both NDIR and FID instruments were used in the CVS technique. The Whittaker "NO<sub>x</sub> Box" was used for determination of oxides of nitrogen in the CVS sample.

The General Motors device was tested on all three cars while the Ford device which is designed only for Ford products was tested only on the Ford Galaxie. The 1962 Chevrolet Biscayne was tested both with a stock carburetor and a lean limit carburetor.

Dynamometer Results

Actual emission levels for the various configurations tested are shown in the appendix to this report. Included in these results are the fuel consumptions obtained for each test.

### GM Device

Table I shows the percent reduction of hydrocarbon, carbon monoxide, and nitric oxide emissions for the four vehicle configurations. As is shown, using the 1968 Federal procedure the average reductions are: 54% less hydrocarbons, 24% less carbon monoxide, and 29% less nitric oxide. Using the 9 cycle CVS test the average reductions change to 37% less hydrocarbons, 19% less carbon monoxide, and 20% less nitric oxides. Using the 1972 proposed Federal procedure reductions were 35% less hydrocarbons, 14% less carbon monoxide and 16% less nitric oxide.

It should be noted that in two cases the constant volume sampling technique indicated an increase in carbon monoxide and nitric oxide with the device installed. This occurred with the 1963 Chevrolet Impala being tested by the 9 cycle CVS test and with the 1962 Chevrolet Biscayne (with lean carburetor) being tested by the proposed 1972 Federal procedure.

### Ford Device

Table II indicates the percent reduction in levels of emissions for hydrocarbon, carbon monoxide, and nitric oxide for the 1963 Ford Galaxie with the Ford device attached. As indicated with the 1968 Federal procedure hydrocarbon was reduced 66%, carbon monoxide 39%, and nitric oxide 57%. With 9 cycle CVS hydrocarbon was reduced by 39%, carbon monoxide increased 9%, and nitric oxide decreased 33%. Using the 1972 proposed Federal procedure hydrocarbon was decreased by 58%, carbon monoxide 27% and nitric oxide 16%.

## Fuel Consumption

### GM Device

Table I shows the relative change in gasoline consumption caused by the attachment of the General Motors device. On the 1968 Federal test procedure (and necessarily the 9 cycle CVS) the average fuel consumption was increased 8% with the kit. An average 6% increase was measured by testing with the proposed 1972 Federal procedure.

### Ford Device

Table II indicates that attachment of the Ford device caused a 27% increase and a 6% increase using the 1968 and 1972 Federal procedures respectively.

### Driveability Effects

Certain qualitative effects on performance were noticed by the test personnel during the running of the test cycles. With installation of the General Motors device the car lost a small but noticeable degree of responsiveness. The effect of application of the Ford device was more severe. The car had a tendency to surge at constant loads. In addition full throttle accelerations were needed to match the cycle acceleration requirement. This was not necessary at all for the uncontrolled vehicle.

### Summary of Results

1. Emissions of all three pollutants, hydrocarbon, carbon monoxide, and nitric oxide, on the average were decreased by the application of a retro-fit device. The constant volume sampling technique used both in the 9 cycle and 1972 Federal procedure showed considerably smaller reduction than did the 1968 Federal procedure.

### Comparison of 1968 FTP and 1972 FTP Results

#### GM Device

|                 | <u>1968 %<br/>Reduction</u> | <u>1972 %<br/>Reduction</u> |
|-----------------|-----------------------------|-----------------------------|
| Hydrocarbon     | 54%                         | 35%                         |
| Carbon Monoxide | 24                          | 14                          |
| Nitric Oxide    | 29                          | 16                          |

#### Ford Device

|                 | <u>1968 %<br/>Reduction</u> | <u>1972 %<br/>Reduction</u> |
|-----------------|-----------------------------|-----------------------------|
| Hydrocarbon     | 66%                         | 58                          |
| Carbon Monoxide | 39                          | 27                          |
| Nitric Oxide    | 57                          | 16                          |

The several increases in carbon monoxide and/or nitric oxide with the device attached indicate that the real effectiveness of the device on some vehicle configurations is marginal.

2. Since all tests showed either no appreciable change or an increase in fuel consumption, it is obvious that one of the penalties of the devices will be increased operating costs.

3. Attachment of a retro-fit device does decrease the vehicles performance, in one case an intolerable amount.

TABLE I

GM Retro-Fit Device  
Percent Reductions\*

|                      | <u>'63 Chevy<br/>Impala</u> | <u>'63 Ford<br/>Galaxie</u> | <u>'62 Chevy<br/>Biscayne<br/>(stock carb)</u> | <u>'62 Chevy<br/>Biscayne<br/>(lean carb)</u> | <u>Average</u> |
|----------------------|-----------------------------|-----------------------------|------------------------------------------------|-----------------------------------------------|----------------|
| <u>'68 Procedure</u> |                             |                             |                                                |                                               |                |
| HC                   | 64%                         | 61%                         | 43%                                            | 48%                                           | 54%            |
| CO                   | 6                           | 25                          | 37                                             | 28                                            | 24             |
| NO                   | 45                          | 41                          | 1                                              | 28                                            | 29             |
| Fuel                 | 19 inc.                     | 6 inc.                      | 6 inc.                                         | 0                                             | 8 inc.         |
| <u>9 Cycle CVS</u>   |                             |                             |                                                |                                               |                |
| HC                   | 29                          | 46                          | 39                                             | 35                                            | 37             |
| CO                   | 16 inc.                     | 21                          | 25                                             | 14                                            | 19             |
| NO                   | 21 inc.                     | 31                          | 2                                              | 24                                            | 20             |
| Fuel                 | 19 inc.                     | 6 inc.                      | 6 inc.                                         | 0                                             | 8 inc.         |
| <u>'72 Procedure</u> |                             |                             |                                                |                                               |                |
| HC                   | 39                          | 49                          | 33                                             | 20                                            | 35             |
| CO                   | 6                           | 26                          | 24                                             | 1 inc.                                        | 14             |
| NO                   | 12                          | 28                          | 22                                             | 2 inc.                                        | 16             |
| Fuel                 | 14 inc.                     | 0                           | 0                                              | 9 inc.                                        | 6 inc.         |

\* Note: "inc." indicates increase

TABLE 11

Ford Retro-Fit Device  
1963 Ford Galaxie  
Percent Reduction\*

'68 Procedure

|      |         |
|------|---------|
| HC   | 66%     |
| CO   | 39      |
| NO   | 57      |
| Fuel | 27 inc. |

9 Cycle CVS

|      |         |
|------|---------|
| HC   | 39      |
| CO   | 9 inc.  |
| NO   | 33      |
| Fuel | 27 inc. |

'72 Procedure

|      |        |
|------|--------|
| HC   | 58     |
| CO   | 27     |
| NO   | 16     |
| Fuel | 6 inc. |

\* Note: "inc." indicates increase

# Appendix

## Emission Test Results

### GM Device

#### 1963 Chevrolet Impala

|                |  |        |        |        |         |
|----------------|--|--------|--------|--------|---------|
| 1968 FTP       |  | HC ppm | CO %   | NO ppm | Fuel kg |
| Without device |  | 909.6  | 3.52   | 371.7  | 1.360   |
|                |  | 867.9  | 3.33   | 534.4  | 1.400   |
| With device    |  | 317.7  | 3.19   | 263.5  | 1.600   |
|                |  | 314.2  | 3.00   | 272.7  | 1.645   |
| 9 Cycle CVS    |  | HC gpm | CO gpm | NO gpm | Fuel kg |
| Without device |  | 11.69  | 75.28  | 1.16   | 1.360   |
|                |  | 10.54  | 75.16  | 1.64   | 1.400   |
| With device    |  | 7.82   | 86.69  | 1.68   | 1.600   |
|                |  | 8.22   | 87.49  | 1.71   | 1.645   |
| 1972 FTP       |  |        |        |        |         |
| Without device |  | 10.78  | 98.41  | 1.93   | 1.400   |
|                |  | 10.27  | 98.45  | 1.73   | 1.505   |
| With device    |  | 5.85   | 85.51  | 1.96   | 1.610   |
|                |  | 7.09   | 98.99  | 1.25   | 1.690   |

#### 1963 Ford Galaxie

|                |  |        |        |        |         |
|----------------|--|--------|--------|--------|---------|
| 1968 FTP       |  | HC ppm | CO %   | NO ppm | Fuel kg |
| Without device |  | 922.7  | 3.81   | 1056.6 | 1.540   |
|                |  | 954.5  | 3.42   | 926.2  | 1.425   |
| With device    |  | 363.3  | 2.66   | 619.3  | 1.575   |
|                |  | 372.8  | 2.73   | 548.8  | 1.565   |
| 9 Cycle CVS    |  | HC gpm | CO gpm | NO gpm | Fuel kg |
| Without device |  | 13.07  | 87.77  | 3.14   | 1.540   |
|                |  | 13.06  | 78.83  | 3.30   | 1.425   |
| With device    |  | 6.73   | 65.07  | 1.86   | 1.575   |
|                |  | 7.39   | 66.98  | 2.56   | 1.565   |

1972 FTP

|                |       |        |      |       |
|----------------|-------|--------|------|-------|
| Without device | 12.21 | 116.48 | 2.99 | 1.685 |
|                | 13.10 | 137.25 | 2.94 | 1.820 |
| With device    | 6.66  | 96.60  | 2.04 | 1.790 |
|                | 6.36  | 91.02  | 2.23 | 1.695 |

1962 Chevrolet Biscayne  
(stock carburetor)

|                |        |      |        |         |
|----------------|--------|------|--------|---------|
| 1968 FTP       | HC ppm | CO % | NO ppm | Fuel kg |
| Without device | 662.5  | 3.96 | 475.7  | 1.630   |
|                |        |      |        |         |
| With device    | 361.4  | 2.39 | 391.2  | 1.760   |
|                | 396.7  | 2.61 | 550.4  | 1.710   |

|                |        |        |        |         |
|----------------|--------|--------|--------|---------|
| 9 Cycle CVS    | HC gpm | CO gpm | NO gpm | Fuel kg |
| Without device | 14.24  | 122.33 | 2.30   | 1.630   |
|                |        |        |        |         |
| With device    | 8.50   | 82.48  | 2.15   | 1.760   |
|                | 8.78   | 101.04 | 2.34   | 1.710   |

1972 FTP

|                |      |        |      |       |
|----------------|------|--------|------|-------|
| Without device | 8.96 | 132.41 | 2.83 | 1.900 |
|                | 8.84 | 128.96 | 2.38 | 1.815 |
| With device    | 5.96 | 106.81 | 1.80 | 1.950 |
|                | 5.90 | 99.57  | 2.04 | 1.760 |

1962 Chevrolet Biscayne  
(lean limit carburetor)

|                |        |      |        |         |
|----------------|--------|------|--------|---------|
| 1968 FTP       | HC ppm | CO % | NO ppm | Fuel kg |
| Without device | 508.1  | 1.91 | 866.4  | 1.755   |
|                | 546.8  | 2.02 | 740.7  | 1.500   |
| With device    | 322.4  | 1.43 | 479.3  | 1.635   |
|                | 229.4  | 1.41 | 670.9  | -----   |

|                |        |        |        |         |
|----------------|--------|--------|--------|---------|
| 9 Cycle CVS    | HC gpm | CO gpm | NO gpm | Fuel kg |
| Without device | 8.40   | 53.02  | 2.92   | 1.755   |
|                | 9.08   | 54.28  | 2.51   | 1.500   |
| With device    | 5.46   | 38.02  | 1.36   | 1.635   |
|                | 5.81   | 53.99  | 2.76   | -----   |

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|          |                |      |       |      |       |
|----------|----------------|------|-------|------|-------|
| 1972 FTP | Without device | 5.99 | 60.05 | 2.47 | 1.630 |
|          |                | 6.49 | 62.90 | 2.70 | 1.660 |
|          | With device    | 4.41 | 53.21 | 2.56 | 1.800 |
|          |                | 5.57 | 71.24 | 2.73 | ----- |

Ford Device

1963 Ford Galaxie

|             |                |        |        |        |         |
|-------------|----------------|--------|--------|--------|---------|
| 1968 FTP    | Without device | HC ppm | CO %   | NO ppm | Fuel kg |
|             |                | 922.7  | 3.81   | 1056.6 | 1.540   |
|             |                | 954.5  | 3.42   | 926.2  | 1.425   |
|             | With device    | 316.7  | 2.26   | 416.6  | 1.900   |
|             |                | 317.9  | 2.13   | 439.1  | 1.860   |
| 9 Cycle CVS | Without device | HC gpm | CO gpm | NO gpm | Fuel kg |
|             |                | 13.07  | 87.77  | 3.14   | 1.540   |
|             |                | 13.06  | 78.83  | 3.30   | 1.425   |
|             | With device    | 8.08   | 96.95  | 2.22   | 1.900   |
|             |                | 7.91   | 84.81  | 2.11   | 1.860   |
| 1972 FTP    | Without device | 12.21  | 116.48 | 2.99   | 1.685   |
|             |                | 13.10  | 137.23 | 2.94   | 1.820   |
|             | With device    | 5.63   | 92.07  | 2.46   | -----   |
|             |                | 5.04   | 92.98  | 2.50   | 1.860   |